Cephalometric Profile of Bangladeshis: Tweed's Analysis

Abstract

Introduction: Tweed's diagnostic triangle is simple yet provides a definite guideline in treatment planning. The aim of the present study was to establish the Tweed's norms for Bangladeshi people. **Methods:** The study was conducted for 89 Bangladeshi young adults (45 males and 44 females), aged 19–27 years, having balanced and harmonious facial profiles. Lateral cephalograms taken of these subjects were used for a series of morphometric analyses. **Results:** All three angular parameters Frankfort-mandibular plane angle (FMA), Frankfort-mandibular incisal angle (FMIA), incise mandibular plane angle (IMPA)were measured and found to be 24.52°, 54.60°, and 100.88°, respectively. The mean FMA has been found to be 24.52° (with a range of 14°–36°) which is quite close to Tweed's norm and found to be statistically insignificant. However, IMPA and FMIA values of Bangladeshis found to be statistically significantly different from that of the Caucasians. The linear regression equation of IMPA on FMA was fitted, and the estimated value of IMPA was computed for a given FMA. **Conclusion:** The results support the idea that treatment objectives of IMPA should be considered according to the facial pattern, i.e., FMA. Ethnic variations of norms cannot be overlooked while outlining goals and planning the treatment.

Keywords: *Cephalometric profile, ethnic variations, linear regression equation, Tweed's diagnostic triangle*

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Introduction

The systematic cephalometric analysis developed by Downs,[1] Steiner,[2] Ricketts,[3] and Tweed[4] are widely accepted. Gradually, several cephalometric analyses specific to racial groups have been established by Cotton,[5] Craven,[6] Mieura,[7] Kam,[8] Drummond,[9] Park's[10] Koreans, Mieura's Japanese, Chan's[8] Chinese, Nanda's[11] North Indians. Garcia's[12] Mexican Americans, Drummond's[9] Negroes, Lim's[13] Filipinos and Bhattarai's[14] Nepalese study.

Tweed's triangle provided the clinician with simple and basic definite guidelines in the treatment planning of malocclusion.[15,16] Tweed's analysis is popularly followed in our country; hence, the present study was undertaken.

Materials and Methods

The material for this study consisted of standardized lateral head roentgenograms of 89 Bangladeshi young adults (45 males and 44 females). The study was conducted in Dhaka Dental College and Hospital Department of Orthodontics and Dentofacial Orthopedics. The subjects were in the age range of 19–27 years. The following criteria were used for selection of subjects; healthy individual with normal growth and development, excellent facial harmony, full complement of fully erupted teeth (excluding third molars) in good occlusion, class I molar and canine relationship, acceptable overjet and overbite, no crowding, no rotations, no cross-bite and a negative history of orthodontic treatment. A lateral head cephalogram was taken for each individual on a standard universal counterbalancing cephalostat. Cephalometric variables were recorded on tracing paper according to Tweed's description. Mean and standard deviation (SD) for all the three variables were computed separately and combined for males and females. The linear regression equation of incise mandibular plane angle (IMPA) on Frankfort-mandibular plane angle (FMA) was fitted, and the estimated value of IMPA was computed for a given FMA.

Written informed consent was obtained from each subject before taking X-ray. Ethical clearance for the study was reviewed and approved by Ethics Committee of Dhaka Dental College Ref: DDC/2016/1766 dated:

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How to cite this article: Rizvi HM, Hossain MZ. Cephalometric profile of bangladeshis: Tweed's analysis. APOS Trends Orthod 2017;7:130-4.

October 16, 2016. This research has also been conducted in full accordance with the World Medical Association Declaration of Helsinki.

Statistical analysis

Programming language R version 3.2 has been used to analyze the data. Descriptive statistics, including the mean, SD, and the range were computed for each variable. The paired *t*-test was performed to compare the sexual differences within the sample. The *t*-test was also used to compare the racial difference with the Tweed's means. The statistical significance for all the tests carried out was defined as $P < 0.05$. S: Significant NS: Nonsignificant.

To provide the clinician with definite guidelines regarding the positioning of mandibular incisor for a given FMA during orthodontic treatment, the mathematical relationship between FMA and IMPA was analyzed using a linear regression equation. Accordingly, the desired IMPA for FMA values ranging from 15° to 35° was calculated. For each value, 95% confidence limit indicating the minimum and maximum values was also calculated and tabulated [Table 1]. Such a table could be kept handy in

Table 1: Predicting incise mandibular plane angle for a patient for his Frankfort-mandibular plane angle (based on Tweed's norms for Bangladeshi adults)

FMA	IMPA	L-IMPA	U-IMPA
15	105.02022	102.27442	107.76601
16	104.58506	102.05108	107.11903
17	104.14989	101.82038	106.47941
18	103.71473	101.58022	105.84925
19	103.27957	101.32774	105.23141
20	102.84441	101.05916	104.62966
21	102.40925	100.76958	104.04891
22	101.97409	100.45295	103.49522
23	101.53893	100.10255	102.97530
24	101.10376	99.71221	102.49532
25	100.66860	99.27805	102.05916
26	100.23344	98.79998	101.66690
27	99.79828	98.28173	101.31483
28	99.36312	97.72941	100.99683
29	98.92796	97.14975	100.70617
30	98.49280	96.54883	100.43677
31	98.05763	95.93162	100.18365
32	97.62247	95.30195	99.94300
33	97.18731	94.66270	99.71193
34	96.75215	94.01601	99.48829
35	96.31699	93.36348	99.27050

The mathematical relationship between FMA and IMPA was analyzed using a linear regression equation (IMPA = α + β FMA + €). Accordingly, the desired IMPA for FMA values ranging from 15° to 35° was calculated. For each value, 95% CL indicating the minimum and maximum values was also calculated and tabulated. CL – Confidence limit; FMA – Frankfort-mandibular plane angle; IMPA – Incise mandibular plane angle; L-IMPA – Lower IMPA; U-IMPA – Upper IMPA

the orthodontic clinic for ready use by the clinician in determining the desired IMPA for a given FMA in a patient, of Bangladeshi origin.

Results

The most relevant data of this study are presented in Tables 2 and 3. All three angular parameters FMA [Figure 1], Frankfort-mandibular incisal angle (FMIA) [Figure 1], IMPA [Figure 1] were measured and found to be 24.52°, 54.60°, and 100.88°, respectively. The difference in the mean values of IMPA, FMA, and FMIA between males and females was found to be statistically insignificant. The mean FMA has been found to be 24.52° (with a range of 14°–36°) which is quite close to Tweed's norm and found to be statistically insignificant. However, IMPA and FMIA values of Bangladeshis found to be statistically significantly different from that of the Caucasians. The linear regression equation of IMPA on FMA was fitted, and the estimated value of IMPA was computed for a given FMA [Table 1 and Figure 2].

Observations and Discussion

Two kindred studies have been published by investigators in local journals of Bangladesh but instead of simply expressing the facts have given birth to perplexity.

Hasan MN *et al*.[17] In their study, have stated that they have collected 112 radiographs (56 males and 56 females) on the basis of having a harmonious face with a convex facial profile (from their photographic record) from patients' record of Orthodontics Department, Faculty of Dentistry, Bangabandhu Sheikh Mujib Medical University, and other two private orthodontic office of Dhaka, Bangladesh.

However, the question remains when you are collecting cephalograms from patients' record needing orthodontic treatment in an orthodontic office having convex profile
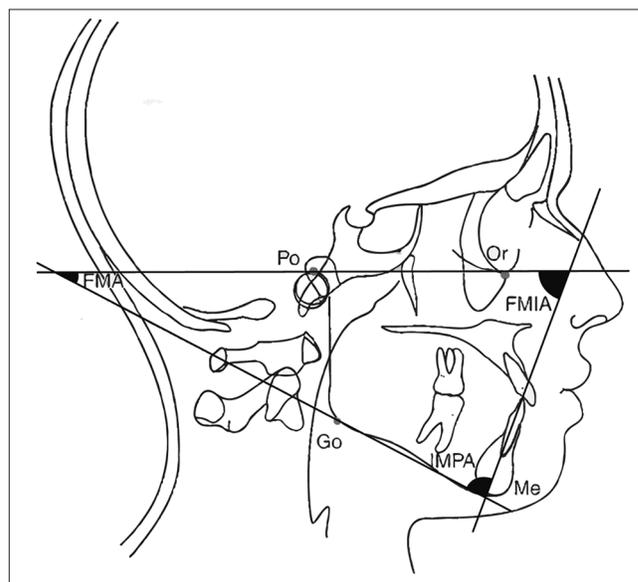

Figure 1: Tweed's analysis with reference points identified

how can you wish to establish the cephalometric norms of that group of people?

Hasan MN *et al*.[17] have further concluded that increased FMA value of Bangladeshi population than that of Caucasian's and Nepalese population indicate Bangladeshis have a bit larger mid-facial height than that of Caucasian's and Nepalese. Furthermore, the Bangladeshis according to them have a significantly low value of IMPA, than that of Caucasian's and Nepalese hence Bangladeshis have incisor teeth that are a bit retroclined than that of Caucasian's and Nepalese. On the other hand, Bari and Hossain[18] in their study, have found that the difference of values of FMA, FMIA, IMPA of Bangladeshis with North Indians were statistically insignificant. The difference of values of FMA, FMIA, IMPA of Bangladeshis with Caucasians was found statistically significant. Yet Kharbanda *et al*.[19] did not find any significant differences of values of FMA of North Indians with Caucasians.

Bari and Hossain[18] concluded that FMIA of Bangladeshis (54.22) was compared with Tweed's value (68.2) is lower for Bangladeshi population suggesting that proclination of lower incisor is more for Bangladeshi subjects than Caucasians.

These contradictory findings of two different groups of investigators of Bangladeshi puerile adults with mean age 19 and 22 with Tweed's analysis surely demand elucidation. Hence, the present study was undertaken.

The Bangladeshi male samples presented a mean FMIA (53.34°) which is slightly smaller than that of the Bangladeshi female sample (55.89°) [Table 2]. The mean difference of 2.55° which is marginally significant ($P = 0.10$) [Table 2] and suggests that Bangladeshi male tend to have more proclined lower incisors than that of the Bangladeshi female subjects. However, no statistical

difference was found in the FMIA between the Bangladeshi male and female samples**.** The difference in the mean values of IMPA and FMA between males and females was also found to be statistically insignificant.

The mean FMA has been found to be 24.52° (with a range of 14°–36°) which is quite close to Tweed's norm, and it was found that there is no statistically significant difference in the mean values between Bangladeshis and Caucasians [Table 3]. However, the FMIA has been found to be only 54.60° (with a range of 39°–71°) [Table 3] which is quite
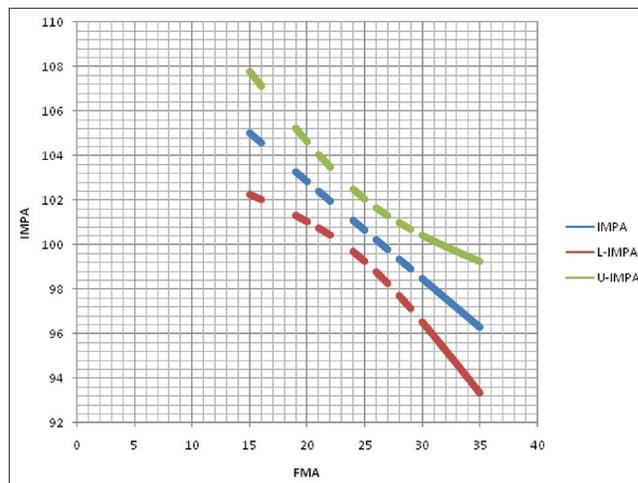

Figure 2: Prediction of incise mandibular plane angle according to Frankfort-mandibular plane angle of the individual as given by the present study based on cephalometric data of Bangladeshis. Normogram constructed using micro soft excel office 2007, XY scatter chart template for determining expected incise mandibular plane angle for a given Frankfort-mandibular plane angle. The correlation was obtained by measuring the angles from 89 normal cephalograms of Bangladeshi young adults. While the area between the red and light green colored lines provide the range of the incise mandibular plane angle for a stipulated Frankfort-mandibular plane angle, the central deep blue line provides the Ideal incise mandibular plane angle

Table 2: Comparisons of the mean angular measurements between male and female Bangladeshi subjects

Parameters	Male (*n*=45)			Female (*n*=44)			Significance	
	Average	SD	Range	Average	SD	Range	P	Remarks
FMA	24.87	5.88	14-35	24.17	5.34	15-36	0.56	NS
FMIA	53.34	7.61	39-71	55.89	6.73	39.5-71	0.10	NS
IMPA	101.79	6.75	88-116	99.94	7.16	87-119	0.21	NS

significance at level *P*<0.05 S: significant NS: Non-significant; FMA – Frankfort-mandibular plane angle; SD – Standard deviation; FMIA – Frankfort-mandibular incisal angle; IMPA – Incise mandibular plane angle

Table 3: A comparison of the mean angular measurements between the Bangladeshi and the Caucasian samples obtained by Tweed's analysis

Parameters	Caucasian norm[16]			Bangladeshi norm total (*n*=89)			Significance	
	Visual mean	Cephalometric mean	Range	Mean	SD	Range	P	Remarks
FMA	25	24.57	15-36	24.52	5.60	14-36	0.54	NS
FMIA	65	68.2	56-80	54.60	7.26	39-71	0.001*	S
IMPA	90	86.93	76-99	100.88	6.98	87-119	0.001*	S

*Significance at level *P*<0.05. S – Significant; NS – Nonsignificant; FMA – Frankfort mandibular plane angle; SD – Standard deviation; FMIA – Frankfort-mandibular incisal angle; IMPA – Incise mandibular plane angle

low compared to Tweed's norm of 65°. The IMPA values in the present study ranged from 87° to 119°, [Table 3] with a mean of 100.88° [Table 3]. This is considerably more than Tweed's mean of 90° suggesting that Bangladeshis have more protrusive mandibular incisors compared to Caucasians. This is an important aspect to be kept in mind when defining the treatment goals for Bangladeshis.

A review of other available studies on various Bangladeshi population groups was made [Table 4][18] and the mean IMPA values were found to range from 83° to 119° [Table 4]. Although there is some variation in the skeletal pattern of different studies of population groups in Bangladesh (the difference in the FMA values in the two races Bangladeshis and Caucasians being very little)., the over-all picture was suggestive of an IMPA value close to 100°, approximately, 10° more than that observed by Tweed, in Caucasians.

Tweed also observed that those subjects whose FMA ranged upward from 25°, demonstrated nature's compensation of a reduced IMPA whereas in those with low or flat FMA (<25°) nature compensated by a higher IMPA, keeping the FMIA relatively constant in all cases.[19] His norms of 25° FMA, 90° IMPA, and 65° FMIA were widely accepted and followed. He also calculated from his studies that for each degree of increase or decrease in FMA, if the IMPA is compensated to maintain the FMIA relatively constant at 65° best results were obtained.

He, therefore, postulated the FMIA is critical for optimal esthetics and suggested that for every degree increase of FMA, the IMPA should be similarly compensated to a minimum of 77°. Likewise, for every decrease of FMA, there should be a compensatory increase of the IMPA, to a maximum of 105°. The findings of the present study also corroborate Tweed's observations. It was observed that the correlation of IMPA with FMA and FMIA was negative and highly significant ($P = 0.001$) indicating that any increase or decrease in the FMA was compensated by an inverse change in the IMPA to maintain good facial harmony.

Interpretations and comments

- In this study, FMA has been found close to Tweed's norms

- FMIA value has been found to be around 55° which is quite low as compared to Tweed's mean of 65°
- IMPA was found to be close to 100°, i.e., 10° more than the value observed in Caucasians suggesting that Bangladeshis have more proclined mandibular incisors as compared to Caucasians
- It has been observed that the correlation of IMPA with FMA and FMIA were negative and highly significant indicating that any increase or decrease in FMA was compensated by an inverse change in the IMPA to maintain good facial harmony.

Conclusion

Tweed's analysis is simple and clinically useful analysis. His norms should be considered only as a guide and not absolute achievable objectives. The treatment objectives of IMPA should be considered according to the facial pattern, i.e., FMA. Racial/ethnic variations of norms cannot be overlooked while outlining goals and planning the treatment.

Conflicts of interest

There are no conflicts of interest.

Table 4: A review of other available studies on various Bangladeshi population groups

Parameters	Norm by Bari and Hossain[18] (n=100)			Norm of the present study (n=89)		
	Mean	SD	Range	Mean	SD	Range
FMA	22.29	6.66	10-43	24.52	5.60	14-36
FMIA	54.22	7.46	34-72	54.60	7.26	39-71
IMPA	103.43	7.63	83-118	100.88	6.98	87-119

FMA – Frankfort-mandibular plane angle; SD – Standard deviation; FMIA – Frankfort mandibular incisal angle; IMPA – Incise mandibular plane angle

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